Affidavit Under 37 CFR 1.132 Docket No.: GREN-001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Art Unit: 3744 Examiner: LEUNG, RICHARD L.

Serial No. 10/816,236 Filed: March 31, 2004

In Re Application of: Conrad Q. Grenfell

For: METHOD AND APPARATUS FOR PRESSURIZING A GAS

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail, in an envelope addressed to Mail Stop: Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA. 22313-1450 on 10/20/05 *, Signed* Krista Thompson

Krista Thompson

AFFIDAVIT UNDER 37 CFR 1.132

I, Conrad Q. Grenfell, am an expert in the natural gas industry, having 42 years of experience in the natural gas industry and 20 years of experience as the owner of a cryogenic natural gas processing plant.

It is respectfully submitted that underground natural gas reservoirs are known in the art to fall into three categories: (1) depleted reservoirs in oil and/or gas fields, (2) aquifiers, and (3) salt cavern formations. In support of this Affidavit, evidence from the website of the Energy Information Administration, which is an agency of the U.S. Department of Energy, is included as support for this knowledge in the field. The evidence is entitled, "The Basics of Underground Natural Gas Storage" and can be found at:

http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/storagebasics/storagebasics.html

Additional evidence from the same website is entitled "Definitions, Sources and Explanatory Notes" and can be found at:

http://tonto.eia.doe.gov/dnav/ng/TblDefs/ng_stor_sum_tbldef.asp

This evidence clearly establishes that an underground natural gas reservoir, as known in the art, includes depleted reservoirs in oil and/or gas fields, aquifiers and salt cavern formations.

Additionally, it is respectfully submitted that Barclay (US 5,505,232) fails to disclose an underground natural gas reservoir, as recited in Claims 1, 11 and 17. The buffer tank 81 cited by Examiner does not constitute an underground natural gas reservoir. A natural gas reservoir is a structure that stores natural gas for use or delivery in the future, while the primary purpose of a buffer tank 81 is a structure that accepts and delivers natural gas simultaneously.

Furthermore, underground natural gas reservoirs are known in the art to be extremely large in order to accommodate high peak demand periods. The system in Barclay "is quite small and compact relative to traditional liquefaction and compression systems for natural gas." (Col. 5, lines 17-19). One of the objects of Barclay is to provide a system "compact enough to be enclosed in a vault underground at refueling stations to reduce land costs and increase safety." (Col. 5, lines 28-30). Therefore, it is clear that buffer tank 81 is not large enough to constitute an underground natural gas reservoir.

Additionally, underground natural gas reservoirs are not structures that are made above ground and then subsequently placed underground, such as buffer

tank 81. Rather, underground natural gas reservoirs are known to be vast spaces that are created in the ground itself.

In support of this Affidavit, evidence from the website of the National Energy Technology Laboratory (NETL) under the U.S. Department of Energy is included as support for this knowledge in the field. The evidence is entitled, "Transmission, Distribution & Storage: Natural Gas Storage" and can be found at:

http://www.netl.doe.gov/scngo/NaturalGas/TD&S/Storage/index.html

Additional evidence provided as "Program facts" from the U.S. Department of Energy is included, entitled "Natural Gas Storage." Even more evidence is included in the form of an article from "techline" entitled, "DOE, Penn State to Establish Gas Storage Technology Consortium: Goal is to Improve Performance of the Nation's Underground Gas Storage Infrastructure" which can be found at:

http://www.netl.doe.gov/publications/press/2003/tl_gasstorage_pennstate.html

All three pieces of evidence disclose that approximately 400 to 415 underground natural gas reservoirs in the United States account for almost 4 trillion cubic feet of storage capacity. That results in an average of approximately 9.6 billion cubic feet of storage capacity per underground reservoir. Even taking into account that some underground reservoirs are smaller than others, the buffer tank in Barclay would not even come close to having the same, or a comparable, storage capacity as even the smallest underground natural gas reservoir. Even if the smallest underground reservoir was 1/1000 the size of this average 9.6 billion cubic feet storage capacity, it would still have a storage capacity of approximately 9.6 million cubic feet. Clearly, the "small and

compact" buffer tank in Barclay that is meant to be placed at refueling stations and reduce land costs has nowhere near the storage capacity of an underground natural gas reservoir.

Therefore, the buffer tank 81 in Barclay clearly does not constitute an underground natural gas reservoir as recited in Claims 1, 11 and 17.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing therefrom.

10-20-05

Conrad Q. Grenfell

Date

eia.doe.gov

The Basics of Underground Natural Gas Storage

Printer-Friendly Version

Latest update: August 2004

Natural gas-a colorless, odorless, gaseous hydrocarbon-may be stored in a number of different ways. It is most commonly held in inventory underground under pressure in three types of facilities. These are: (1) depleted reservoirs in oil and/or gas fields, (2) aquifers, and (3) salt cavern formations. (Natural gas is also stored in liquid form in above-ground tanks. A discussion of liquefied natural gas (LNG) is beyond the scope of this report. For more information about LNG, please see the EIA report, *The Global Liquefied Natural Gas Market: Status & Outlook*.) Each storage type has its own physical characteristics (porosity, permeability, retention capability) and economics (site preparation and maintenance costs, deliverability rates, and cycling capability), which govern its suitability to particular applications. Two of the most important characteristics of an underground storage reservoir are its capacity to hold natural gas for future use and the rate at which gas inventory can be withdrawn-its deliverability rate (see *Storage Measures*, below, for key definitions).

Most existing gas storage in the United States is in **depleted natural gas or oil fields** that are close to consumption centers. Conversion of a field from production to storage duty takes advantage of existing wells, gathering systems, and pipeline connections. Depleted oil and gas reservoirs are the most commonly used underground storage sites because of their wide availability.

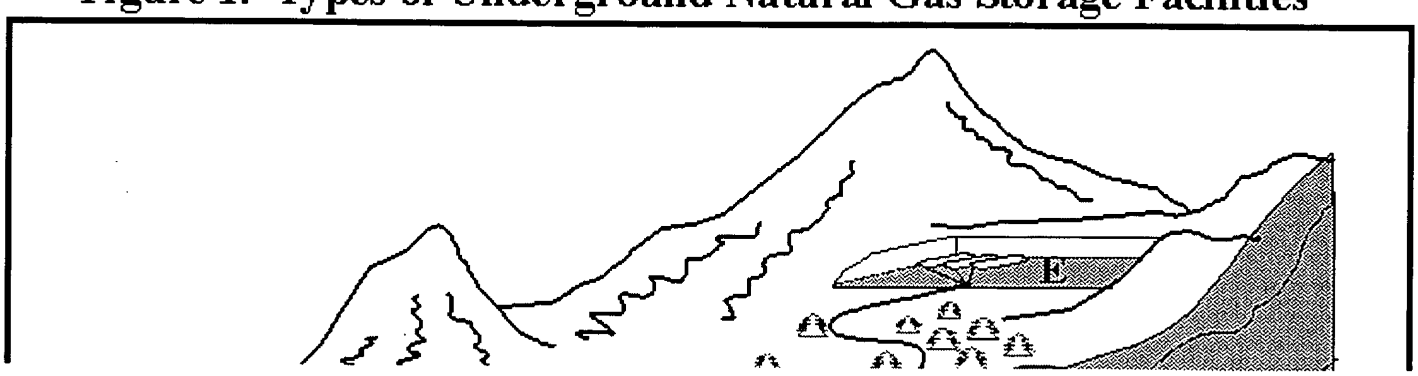
In some areas, most notably the Midwestern United States, natural **aquifers** have been converted to gas storage reservoirs. An aquifer is suitable for gas storage if the water bearing sedimentary rock formation is overlaid with an impermeable cap rock. While the geology of aquifers is similar to depleted production fields, their use in gas storage usually requires more base (cushion) gas and greater monitoring of withdrawal and injection performance. Deliverability rates may be enhanced by the presence of an active water drive.

Salt caverns provide very high withdrawal and injection rates relative to their working gas capacity. Base gas requirements are relatively low. The large majority of salt cavern storage facilities have been developed in salt dome formations located in the Gulf Coast states. Salt caverns have also been leached from bedded salt formations in Northeastern, Midwestern, and Southwestern states. Cavern construction is more costly than depleted field conversions when measured on the basis of dollars per thousand cubic feet of working gas capacity, but the ability to perform several withdrawal and injection cycles each year reduces the per-unit cost of each thousand cubic feet of gas injected and withdrawn.

There have been efforts to use abandoned **mines** to store natural gas, with at least one such facility having been in use in the United States in the past. Further, the potential for commercial use of **hard-rock cavern** storage is currently undergoing testing. None are commercially operational as natural gas storage sites at the present time.

Figure 1 is a stylized representation of the various types of underground storage facilities, while Figure 2 shows the location of the nearly 400 active storage facilities in the Lower 48 States.

Figure 1. Types of Underground Natural Gas Storage Facilities



Energy Information Administration

EIA Home ▶ Natural Gas ▶ Navigator

Definitions, Sources and Explanatory Notes

Category: Natural Gas Storage

Topic: Underground Storage - All Operators

Definitions

Key Terms	Definition
Natural Gas	A gaseous mixture of hydrocarbon compounds, the primary one being methane.
Underground Gas Storage	The use of sub-surface facilities for storing gas that has been transferred from its original location. The facilities are usually hollowed-out salt domes, natural geological reservoirs (depleted oil or gas fields) or water-bearing sands topped by an impermeable cap rock (aquifer).
Base (cushion) gas	The volume of gas needed as a permanent inventory to maintain adequate reservoir pressures and deliverability rates throughout the withdrawal season. All native gas is included in the base gas volume.
Working (top storage) gas	The volume of gas in the reservoir that is in addition to the cushion or base gas. It may or may not be completely withdrawn during any particular withdrawal season. Conditions permitting, the total working capacity could be used more than once during any season.
Underground Storage Injections	Gas from extraneous sources put into underground storage reservoirs.
Underground Storage Withdrawals	Gas removed from underground storage reservoirs.
Storage Additions	Volumes of gas injected or otherwise added to underground natural gas reservoirs or liquefied natural gas storage.
Storage Withdrawals	Total volume of gas withdrawn from underground storage or from liquefied natural gas storage over a specified amount of time.
Net Withdrawals	The amount by which storage withdrawals exceed storage injections.

For definitions of related energy terms, refer to the EIA Energy Glossary.

Sources

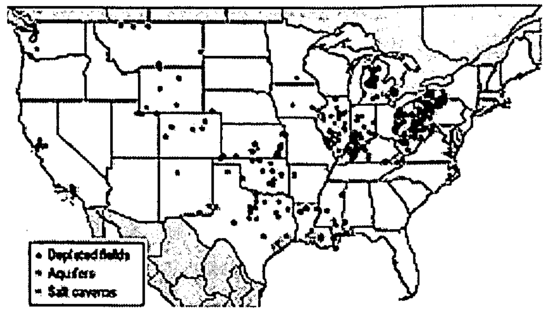
1979 and prior data from the American Gas Association, Committee on Underground Storage, *The Storage of Gas in the United States and Canada*. 1980 to current data from Form EIA-191, "Monthly Underground Gas Storage Report" .

Explanatory Notes

- Net storage withdrawals data through 2003 include underground storage and liquefied natural gas storage. Data for January 2004 forward include underground storage only.
- Gas in storage at the end of a reporting period may not equal the quantity derived by adding or subtracting net injections or withdrawals during the period to the quantity of the gas in storage at the beginning of the period. This is due to changes in the quantities of native gas included in base gas and/or losses in base gas due to migration from storage reservoirs.
- Totals may not equal sum of components due to independent rounding.
- Positive net withdrawals indicate the volume of withdrawals in excess of injections. Negative net withdrawals indicate the volume of injections in excess of withdrawals.

Transmission, Distribution & Storage
Natural Gas Storage

The consumption of natural gas varies day-to-day and month-to-month. Weather and the demands of electric power generation translate into usage fluctuations. Seasonally the fluctuation is as much as 50%, and short term it can be even more variable. Exact timing, location, and volume of peak demand is unpredictable. Since natural gas is not produced in a way that corresponds to these fluctuations, surplus gas is pumped during slumps in usage into numerous storage facilities for use during inevitable surges in consumption. This allows continuous service even when production or pipeline transportation services can not meet demand.



Click on image above to see larger view

- Salt Cavern Storage
- Rock Cavern Storage
- Alternative Storage Concepts
- Reservoir Management
- Deliverability
- Natural Gas Storage Technology Consortium

To enhance the more than 1.4 million miles of pipelines, natural gas is stored in two basic ways – compressed in tanks as liquified natural gas (LNG) or in large underground storage facilities such as depleted gas wells, salt or rock caverns, abandoned mines, and aquifers. By far, the greatest volume of gas is stored by this second method, usually in depleted gas wells. Each year, from April to November, operators inject excess summer production into approximately 415 storage reservoirs across the country. Most of these facilities are located near major eastern and mid-continent markets. They account for almost 4 trillion cubic feet of storage capacity, or over 15% of one year's national gas consumption. This storage system serves the market place in several ways. Most importantly, it allows consistent delivery of the natural gas resource to consumers. Second, it stabilizes supply by sustaining production levels in the summer and eliminating shortages in the winter. Third, it eliminates the need for expensive, additional pipeline transmission capacity that would be necessary to supply peak demand. Finally, it provides confidence in and encourages the use of an environmentally friendly, clean burning fossil fuel.

The National Energy Technology Laboratory and the Strategic Center for Natural Gas and Oil (SCNGO)face difficult technological challenges as increased demand, demographics, and deterioration burden our present storage system. The use of natural gas is projected to increase at a rate of 1.4% per year for the next 2 decades. During this time, there will be a significant shift in consumption patterns as population centers change and more natural gas is utilized in the production of electricity to power summer air conditioning. Present storage wells must be renewed or replaced as older storage areas experience "wear" due to the yearly cycles of injection and extraction of gas.

The SCNGO will develop innovative methods of natural gas storage to enhance operational flexibility of the nation's gas storage system while ensuring the integrity, operational reliability, safety, and security of the nation's entire natural gas infrastructure. In 2004, the SCNGO's Natural Gas Delivery, Storage, and LNG Program in collaboration with Pennsylvania State University established the Natural Gas Storage Technology Consortium (GSTC). The GSTC mission is to assist in the development, demonstration, and commercialization of advanced storage technologies. Currently, the membership includes 40 individual companies or organizations. The GSTC will be the cornerstone ot future storage R&D efforts.

PROGRAM facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Strategic Center for Natural Gas

03/2004

NETL

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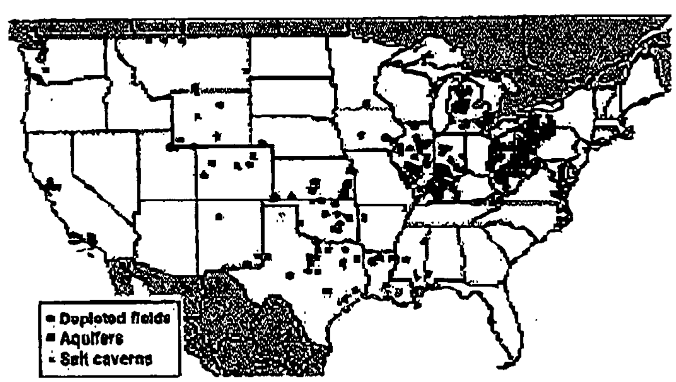
Natural Gas Storage

The consumption of natural gas varies day to day and month to month. Weather and the demands of electric power generation translate into usage fluctuations. Seasonally the fluctuation is as much as 50% and in the short term it can be even more variable. Exact timing, location and volume of peak demand are unpredictable. Since natural gas is not produced in a way that corresponds to these fluctuations, surplus gas is pumped during slumps in usage into numerous storage facilities for use during inevitable surges in consumption. This allows continuous service even when production or pipeline transportation services can not meet demand.

The natural gas storage system serves the market place in several ways. Most importantly, it allows consistent delivery of the natural gas resource to consumers. Second, it stabilizes supply by sustaining production levels in the summer and eliminating shortages in the winter. Third, it eliminates the need for expensive, additional pipeline transmission capacity that would be necessary to supply peak demand. Finally, it provides confidence in and encourages the use of an environmentally friendly, clean burning fossil fuel.

To enhance the more than 1.3 million miles of pipelines, natural gas is stored in two basic ways – in tanks as liquefied natural gas (LNG) or in large underground storage facilities such as depleted gas/oil reservoirs, salt caverns, and aquifers. By far the greatest volume of gas is stored by this second method, mainly in depleted gas fields. Each year, from April to November, operators inject excess summer production into approximately 410 storage reservoirs across the country, most of which are located near major eastern and mid-continent markets. They account for almost 4 trillion cubic feet of storage capacity, or nearly 20% of one year's national gas consumption.



Natural Gas Storage Facilities in the United States

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

STRATEGIC CENTER FOR NATURAL GAS WEBSITE

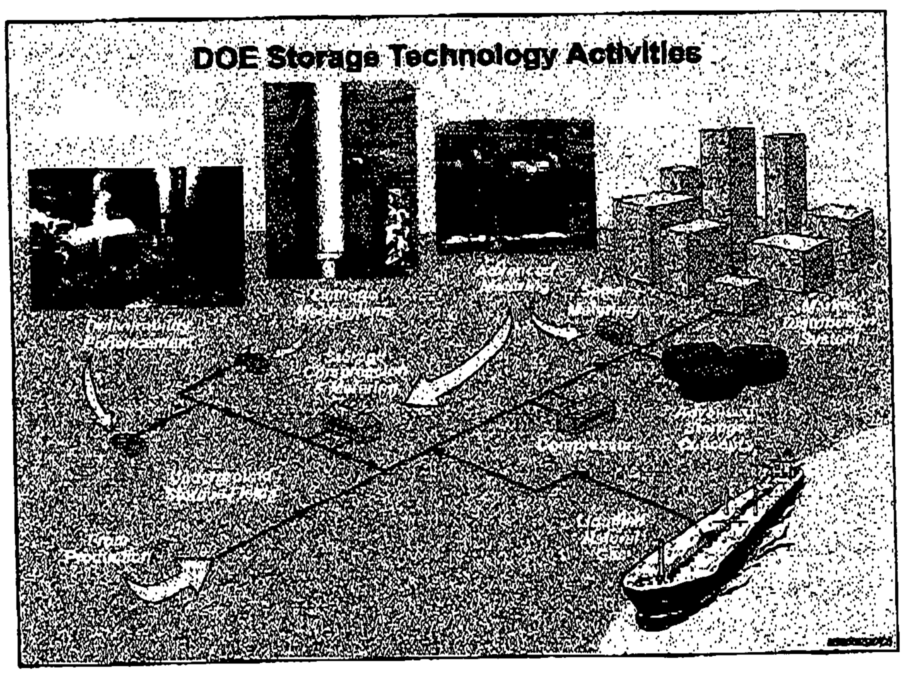
www.netl.doe.gov/scng

The natural gas storage industry faces difficult technological challenges as increased demand, demographics, and deterioration burdens our present storage system. There will be a significant shift in consumption patterns as population centers change and more natural gas is utilized in the production of electricity for summer air conditioning. Present storage wells must be renewed or replaced as older storage areas experience "wear" due to the yearly cycles of injection and extraction of gas.

To address these challenges, the goal of the Natural Gas Storage Program is to enhance the operational flexibility of the nation's gas storage system while ensuring the integrity, operational reliability, safety and security of the nation's entire natural gas infrastructure. Based on a collaborative approach to identify priorities and opportunities for research and development (R&D) funding, projects supported by DOE are developing technologies to ensure the availability of clean, affordable energy for our homes, businesses, and industries.

Current technology development efforts include:

- A newly established Gas Storage Consortium will provide a means to accomplish industry-driven R&D designed to enhance efficiency and deliverability from gas storage facilities.
- Development of improved gas metering technologies to provide increased accuracy and operational efficiency, and to enable existing flow meters to determine energy flow rate.
- Advanced storage technologies that will provide flexible storage service to meet the needs of new and growing industrial and power generation markets in areas without conventional storage geology. Examples include:
  - creating cavernous storage in carbonate rocks using a novel acid dissolution process
  - gas storage as hydrates



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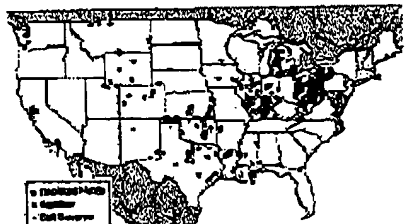
techline

Issued on: September 11, 2003

DOE, Penn State To Establish Gas Storage Technology Consortium

Goal Is to Improve Performance of the Nation's Underground Gas Storage Infrastructure

University Park, PA - The Pennsylvania State University has been selected by the U.S. Department of Energy to establish and operate an underground gas storage technology consortium.



FOSSIL FACT: The nation's gas industry stores natural gas in more than 400 underground storage reservoirs and salt caverns throughout the country. Click here for larger image

The agreement between Penn State and DOE's National Energy Technology Laboratory Strategic Center for Natural Gas will last four-and-a-half years at a total cost of $3 million. The first phase of the agreement will last 18 months to allow creation of the consortium structure, solicit membership and establish an executive panel of industry experts, refine a technical approach for deliverability enhancement and reservoir management research, and select and award the first round of research projects.

The consortium will be industry-driven, and emphasize the creation of a balanced research portfolio of practical solutions, short-term projects, and basic research to improve the performance of the nation's gas storage infrastructure.

Most natural gas produced in the United States requires long distance transmission to reach its ultimate end user. The nation uses 1.5 million miles of natural gas pipelines capable of moving 111 billion cubic feet of gas daily to service customers. However, the need for gas fluctuates more quickly than can be accommodated by the production and pipeline systems. In general, demand varies seasonally, but the exact timing and magnitude of peak demand is determined largely by the weather, and is therefore unpredictable.

To manage this risk, natural gas is injected into more than 400 underground storage reservoirs and salt caverns each year from April through October. These storage reservoirs and caverns provide roughly 4 trillion cubic feet of gas to help meet both seasonal and peak demands. Together, natural gas pipelines and underground gas storage create a distribution system that efficiently balances the need for steady year-round gas production with seasonal variations in demand.

That efficiency will be tested in the years to come as natural gas demand is expected to grow from 22 trillion cubic feet per year today, to almost 35 trillion cubic feet by 2025. This demand will be met by increased production of domestic natural gas from both conventional and unconventional sources, as well as growth of a true world market for liquefied natural gas. The expansion in both the volume and nature of gas use will place significant new burdens on the nation's existing pipeline and storage systems.

Gas storage research focuses primarily on two main issues. First, gas storage wells/fields often suffer a decline in productivity after several years of withdrawal and

injection cycling. Current revitalization techniques usually provide only limited, temporary delivery restoration. Second, not all regions of current and potential high gas demand possess natural underground reservoirs or salt formations that can support local storage needs.

Research supported by the consortium will include, but not be limited to, technologies to limit and remediate the progressive damage caused by the repeated injection and withdrawal of gas in existing and future facilities, as well as innovative reservoir development and management techniques that can maximize performance. Moreover, research will focus on developing, in close proximity to demand centers, man-made storage systems such as underground mined caverns, gas hydrate storage, distributed liquefied natural gas, and other non-traditional means.

-End of *TechLine* -

For more information, contact:

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